

The Mole

How much matter



What it is?

- The **mole is the standard unit of measurement in chemistry** for indicating the amount of a substance present.
- **The symbol for mole is "mol"**
- The technical definition:
 - The mole is the amount of substance of a system, which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

More definition

- **1 mole of molecules has a mass equal to the molecular weight in grams.**
- examples
 - 1 mole H_2O is the number of molecules in 18.015 g H_2O
 - 1 mole H_2 is the number of molecules in 2.016 g H_2 .
- **1 mole of atoms has a mass equal to the atomic weight in grams.**
 - 1mole Cu is the number of atoms in 63.546 g copper.
 - 1 mole Au is the number of molecules in 197.9665 g gold
- **1 mole of any gas will occupy 22.4 liters at standard temperature and pressure**
 - Standard temperature is 0°C or 273.15 K
 - Standard pressure is 29.92 in Hg or 1 atmosphere or 760 mm Hg

More definition

- **1 mole of particles = 6.02214×10^{23} particles for any substance!**
 - 1 mole chocolate chip cookies is 6.02214×10^{23} Cookies
 - 1 mole Fe is 6.02214×10^{23} iron atoms
- **molar mass** is the mass of one mole of a substance
 - bridge between moles and grams in unit conversion problems

Why?

- Since we cannot see atoms or molecules or ions to count them; we need a way to measure the amount of matter we are working with.
- masses of substances in grams are weighed on an electronic balance. That number can then be converted into moles.
- We will need to use moles in Stoichiometry, which is the math of chemical equations.

What needs to be done

- We can convert a number of particles into moles but that isn't going to give me what is needed.
- **The skill required here is to be able to convert from grams to moles, moles to grams, liters of gas to moles, moles to liters of gas and etc.**

Converting to and from moles

- Grams of an element to moles: divide # grams by atomic weight

– Example: 47.5 g Cu $\frac{47.5 \text{ g Cu}}{63.54 \text{ g Cu/mol}} = 0.75 \text{ mol Cu}$

- moles of an element to grams: multiply # moles by atomic weight

- Example: 1.7 mol Zn

$$1.7 \text{ mol Zn} \times \frac{65.4 \text{ g Zn}}{1 \text{ mol}} = 111.2 \text{ g Zn}$$

Examples

- How many moles of sulfur are in 104.01 grams?

Examples

- How many grams of iron are in 33.7 moles Fe?

Examples

- How many moles of aluminum nitrate [$\text{Al}(\text{NO}_3)_3$] are in 107.6 grams?

Converting to and from moles

- liters of a gas to moles: divide # liters by 22.4 L
– Example: 72.1 L of H₂

$$\frac{72.1 \text{ L H}_2}{22.4 \text{ L/mol}} = 3.22 \text{ mol H}_2$$

- moles of gas to liters: multiply # moles by 22.4 L/mol
– Example: 6.75 mol He

$$6.75 \text{ mol He} \times 22.4 \text{ L/mol} = 151.2 \text{ L He}$$

Examples

- How many moles of H_2 gas are in 447.6 L?

Examples

- How many liters of N_2 gas are in 3.75 moles?

all in one

- How many grams of O₂ are in 34.3 L?

$$\frac{34.3 \text{ L O}_2}{22.4 \text{ L/mol}} \times \frac{31.9 \text{ g O}_2}{\text{mol}} = 48.8 \text{ g O}_2$$

- How many liters of Ne are in 33.7 g ?

$$\frac{33.7 \text{ g Ne}}{20.18 \text{ g/mol}} \times \frac{22.4 \text{ L Ne}}{\text{mol}} = 37.4 \text{ L Ne}$$

Examples

The End



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"Talk about trunk space, this beauty has thirteen cubic feet! That's enough room to hold more than sixteen moles of any gas at STP."